THE IMPACT OF MATHEMATICS ANXIETY, GENDER, AND MATHEMATICS ACHIEVEMENT ON ONTOGENETIC INDICATORS FOR HISPANIC/LATINO STUDENTS IN HIGHER EDUCATION MATHEMATICS CLASSES

A Dissertation

by

ARMANDO ISAAC PÉREZ

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2005

Major Subject: Curriculum and Instruction

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Approved by:

Co-Chairs of Committee,	Gerald O. Kulm
	Robert M. Capraro
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ABSTRACT

The Impact of Mathematics Anxiety, Gender, and Mathematics Achievement on Ontogenetic Indicators for Hispanic/Latino Students in Higher Education Mathematics Classes. (August 2005)

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Co-Chairs of Advisory Committee: Dr. Gerald O. Kulm
Dr. Robert M. Capraro

A convenience sample of 123 Hispanic/Latino students from a predominantly Hispanic/Latino South Texas community college was used to determine if gender and/or journal-writing had any effects on mathematics anxiety or achievement. Eight sections of college-algebra courses were administered the Mathematics Anxiety Rating Scale (MARS) to determine levels of mathematics anxiety and the Texas Higher Education Assessment (THEA) to determine levels of mathematical achievement. Results of the study suggest that journal-writing decreases levels of mathematics anxiety among students. In addition, the study suggests that males and females do not differ in terms of mathematical achievement. These finding are consistent with previous studies. However, the study also suggested that males and females report the same levels of mathematics anxiety and that journal-writing does not increase mathematical achievement. This is in contrast to previous published studies.

DEDICATION

I dedicate this work to Almighty God. For it is through Him that all good things come. I also dedicate this work to my parents Humberto and Idalia. Through God you gave me life and love. Thank you.

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Earning a Ph.D. is not an easy task. While many people accomplish this on their own, I was fortunate enough to have a great support system in place to continue to motivate and inspire me. There were many difficult times and always my friends and family understood what a complex journey I was going through. I am grateful for the times I was “left alone” to do what I needed to do and for the times I was “coerced” into leaving my house for some rest and relaxation. There are many people to thank, and if by any chance I miss someone, believe me, it was not intentional. Almighty God, with Your help and guidance we accept Your goodness. Mom and Dad, thank you for being you. My life could have turned out so differently and I thank you for raising me in the best possible way. I love you deeply and only hope that one day I have kids of my own and am able to do as great a job as you did with me. Carmen, thanks for fighting with me when we were kids. I always looked up to you as my big sister and still do today. You are always in my thoughts and prayers. I love you. Alicia and Andrea, my first nieces. What a joy (and pain) to have you in my life. I wouldn’t trade the feeling for anything in the world. One day you will read this page and laugh at your uncle. Melissa Denise, you are the love of my life. Not many people could have put up with me these past few years. There were many times I had to work on my dissertation and you were always there to support me. Thank you for sacrificing your time so I could accomplish this goal. Thank you for always being there when I needed someone to talk to. Dr. Robert M. Capraro, thank you for welcoming me to your life. Your guidance and mentoring will never be forgotten. There are so many things I would like to thank you for academically, but I prefer to thank you for all the personal assistance you freely gave to me. In particular, thank you for the phone call when I most needed it. Dr. Mary M. Capraro, thank you for also allowing me to be part of your life. You welcomed me into your home and were always willing to help me accomplish my goals. Thank you for being at my dissertation defense and for your words of wisdom. Dr. Gerald O. Kulm, thank you for co-chairing my committee. You are a generous person and I appreciate all you did for me. Thank you for always answering my emails (there were many), for making the dissertation process as smooth as possible, and for your great advice. Dr. Jon. T. Pitts, thank you for agreeing to serve on my committee. I still recall the first time you explained a geometry concept that was difficult to understand. Your patience and willingness to teach are truly marvelous. Dr. G. Donald Allen, thank you for serving on my committee. I am continually learning new ideas in mathematics and I owe that to you. Dr. Charles E. Lamb, you were my first mentor at Texas A&M. Thank you for your support and advice during your tenure at the university. Ana, got scrabble? Anabel, thank you for all the time you spent helping me get organized. Ari, you will always be the great communicator. Cyndee, thanks for all the laughs we shared during the summers. Remember Ringer? David, Laura, and Brenda, thank you for helping me accomplish my goal. Debbie, the wax queen. Does 2.54 sound familiar? Elsa, my partner in mathematics. Who can forget the all-nighters solving mathematics problems. Fili, I never get tired of those funny emails. Thank you for being part of my life. Gil, you are a unique individual. Thanks for all your help and advice with all aspects of this degree. Ileana, you are a life-saver. Thank you for all your time and dedication. You made my job much easier. Juan Dagoberto, what can I say buddy? Thanks for always being there and for all the memories we have shared. Thanks for being in College Station when we couldn't get served a meal. L. J., thanks for all the great times we shared making the rounds all over town. Lil'G, thank you for taking time from your schedule to help me sort out my study. Master Ovid, thank you for allowing me the opportunity to learn the martial arts. Paul, thank you for taking me to relax when I needed to take a break from work and school. Thanks for the intellectually stimulating conversations. You are the great philosopher. Queta, thank you for always being supportive of me. Ricoman, thanks for giving me the opportunity to teach at a community college. Rosslynn, thank you for helping me with my first semester at Texas A&M. Tony, thanks for the laughs we shared and for all the money you spent on gas while we were driving around. Was it Juan's fault we never got served food? Yoli, thank you for always helping me. You always know what to do.

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CHAPTER I

INTRODUCTION

Background

It is a shame we do not encourage our students and our children to truly learn mathematics (Bennett et al., 1998; Draper, 2002). The unfortunate scenario that takes place in many minority U.S. households is a familiar one: A child complains that mathematics is difficult to understand. The parent, trying to provide comfort, compounds the problem by saying they were never good at mathematics either and that they have not had a need to use it in their lives. Minorities in particular look to their parents for guidance and as Baroody & Coslick (1998) discuss, they are led to believe that they are just not meant to be mathematically capable. These negative attitudes must be changed if we wish to increase mathematical abilities among our students. In addition, the mathematics community needs to review the manner in which educators are teaching mathematics to ensure that the most effective techniques, primarily based on research data are implemented.

From time to time, some educators may begin questioning whether their students are truly learning mathematics. In addition, they may take it as a personal attack on their teaching effectiveness if the students somehow fail to grasp the concepts.

This dissertation follows the style and format of the *Journal for Research in Mathematics Education.*

With this in mind, consider a mathematics teacher who poses a question and does not receive feedback and/or receives an incorrect response. The temptation might be to divulge the answer to the class. This may allow the instructor to continue the lesson, meet the stated goals for that particular day, or just make himself/herself feel like something has been accomplished. The students may not be given the opportunity to discover the solution themselves; rather, they may begin learning that the teacher will ultimately supply the correct answer if the class is unable to do so. This of course, is not the goal of mathematics education.

A teacher should be hesitant about providing solutions and instead should try to promote the critical thinking skills that are most crucial to students. The question to consider is “At whose expense?” After all, “sometimes it is necessary to go through panic before we find solutions” (Smith, 2000, p. 380). It would seem more intuitive that “the students gain far more understanding and joy from the exercise by working it out themselves than by having [the instructor] give them the correct answer" (Borko & Peressini, 2000, p. 199).

Successful teaching and learning is composed of many variables. To begin with, having an effective dialogue with students means that a teacher should be patient and wait at least three to five seconds after asking a question before expecting a good response (Chambers, Munday, Sienty & Justice, 1999; Needham, 1994). Moreover, questions should be thought out in advance so that there is a mix of both product-oriented and process-oriented questions, with more of an emphasis placed on the latter (Reinhart, 2000). The era of direct lecture should not be forgotten, but neither should it be the primary means of instruction. What needs to be remembered is that a lecture is just "the transfer of information from the notes of the lecturer to the notes of the student without passing through the minds of either" (Reinhart, 2000, p.480).

Students often complain that they need to memorize too many formulas (Buxton, 1981; Greenwood, 1984), not all problems are the same, and that there is just too much information to remember (Buxton, 1981). They do not feel confident studying and/or taking a mathematics examination. One way to address this situation is to allow students to use their books and/or notes for the test. After all, even medical doctors need to consult reference books when they cannot recall some information.

Some students see mathematics as a complicated subject that serves no purpose in the "real world." They just do not seem to understand the subject. This may be because some previous teachers "turned them off" or because mathematics may appear to them as just a series of numbers. Students may be afraid of mathematics because of all the formulas they need to remember (Jehlen, 2001), because most problems are different, or because they have not developed the necessary critical thinking and analytical skills necessary for success. Eventually, students may begin to experience great apprehension regarding mathematics. This situation is commonly referred to as mathematics anxiety.

Cemen (1987) defines mathematics anxiety as uncomfortable feelings that result from situations involving mathematical tasks. As a result, this anxiety can lead to more radical conditions such as panic, hopelessness, stomach pains, and loss of concentration (Buxton, 1981; Clawson, 1991; Godbey, 1997; Kogelman & Warren, 1978; Richardson

& Suinn, 1972). Mathematics anxiety can affect students by limiting their choice of majors and careers (Alderman, 1999; Betz, 1978; Ho et al., 2000; Richardson & Suinn, 1972; Trice & Ogden, 1986; Zettle & Raines, 2000). This aspect of mathematics anxiety is of great concern to both teachers and pupils (Richardson & Suinn, 1972).

Mathematics anxiety is one of the most commonly cited excuses used by students, parents, and teachers to justify poor performance on mathematics assessments. This should cause some concern, especially among elementary education majors who experience disproportionately high levels of mathematics anxiety as compared to non-elementary education majors (Fiore, 1999; Levine, 1996; Trent, 1987; Williams, 1988). This sense of anxiety tends to lead to self-doubt about their effectiveness in teaching mathematics to young children (Ho et al., 2000; Levine, 1996; Trice & Ogden, 1986). In addition, teachers who are mathematically anxious or who show a dislike towards mathematics usually pass these fears on to their students (Buxton, 1981; Fiore, 1999; Hembree, 1990; Jackson & Leffingwell, 1999; Martinez, 1987; Williams, 1988). It is no wonder then that many students today prefer to avoid courses dealing with mathematics.

It is widely recognized that mathematics plays a significant role for all people regardless of their occupation (Nelson, 2001). Mathematics has been and will continue to be a driving force behind many of today's technological accomplishments (Furner & Duffy, 2002; Hrabowski, 2003; Joshi, 1995; Justiz, 1994). As such, it is imperative that the United States be competitive with nations like Japan, Germany, and South Korea in terms of mathematical achievement (Stevenson & Stigler, 1992; Stigler, Fuson, Ham, & Kim, 1986; Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999; Stigler, Lee, &

Stevenson, 1990).

The 1957 launching of Sputnik by the Soviet Union helped boost mathematics knowledge across all grade levels (Frelindich, 1998). Since then, it seems as if there has not been enough support to continue to foster mathematical growth among U.S. students (Frelindich, 1998). This is especially true when it comes to females and Hispanic/Latino students. These groups have been historically underrepresented in the mathematical fields and they consistently fail to take advanced mathematics courses and/or pursue career paths related to mathematics (Hrabowski, 2003; Morgan, Isaac, & Sansone, 2001; National Council of Teachers of Mathematics [NCTM], 2002).

The controversy between male and female achievement in mathematics is something that should be reviewed in-depth. People tend to believe that mathematics is a male oriented subject (Skaalvik & Skaalvik, 2004). This misconception may lead educators to push the male students to succeed, while at the same time discouraging females from pursuing higher-level mathematics courses.

Some people may perceive mathematics to be a subject that deals only with numbers and not as a field where effective interpersonal communication skills are a prerequisite for mathematical comprehension. A possible key to understanding mathematics is being able to understand the vocabulary and thus the unique language associated with it. Oftentimes students might lack these necessary skills; hence, it may lead to an increase in their reported levels of mathematics anxiety and frustration.

One way to help overcome this problem may be to have students keep a mathematics journal where they can write on topics that trouble them such as definitions, concepts, or worries about the mathematical learning process. Miller (1992) defines journal writing as having students write down their thoughts or feelings about mathematics in general and/or any problems in specific that they may not understand.

Similarly, Burton (1985) describes journal writing as brainstorming with oneself. Journal writing can be an effective tool in lowering levels of mathematics anxiety and improving attitudes towards the subject since students are able to express their fears and worries in a relaxed environment (Borasi & Rose, 1989). In addition, previous research on writing in mathematics and/or statistics classes has shown that it helps increase mathematical achievement and decrease levels of anxiety (Ganguli, 1989; Sgoutas-Emch & Johnson, 1998; Grossman, Smith, & Miller, 1993; Miller, 1992).

Purpose of the Study

The purpose of this study will be to determine if there are differences in mathematics anxiety or mathematics performance for Hispanic/Latino male and female students enrolled in college algebra courses at a predominantly native Spanish speaking South Texas community college and if there is a relationship between a person's reported level of mathematics anxiety and their performance on mathematics tests. Finally, the study seeks to determine if students who participate in a journal writing program experience improvements in their reported levels of mathematics anxiety or in their mathematics performance. Specifically, the study investigated the following questions: (1) Does there exist a statistically significant difference in reported levels of mathematics anxiety between Hispanic/Latino male and female students enrolled in college algebra courses at a predominantly native Spanish speaking South Texas community college? (2) Does there exist a statistically significant relationship between a person's reported level of mathematics anxiety and their performance on mathematics tests? (3) To what extent, if any, does gender play a role in success on mathematics tests for higher education students? (4) Do students who participate in a journal-writing program experience a statistically significant change in their reported levels of mathematics anxiety? (5) Does there exist a statistically significant difference in performance on mathematics tests between students who participate in a journal-writing program and those who do not participate in the program?

Limitations of the Study

There was one true limitation for this study. The treatment portion of the study was conducted within a three-week span. As a result of this relatively short time span, some students may not have reduced their reported levels of mathematics anxiety to measure levels within the tolerance of the measurement instrument.

Definition of Terms

The terms used in this study are:

A low level of mathematics anxiety refers to students who scored at or below the 10th percentile for the pretest MARS as per the study's results.

A high level of mathematics anxiety refers to students who scored at or above the 80th percentile for the pretest MARS as per the study's results.

College-age student/Traditional student refers to students between the ages of 18-25 who are enrolled in a community college.

College-level course refers to a course taken after a prerequisite course. Traditionally, the course is college algebra.

Journal writer refers to a treatment used with the experimental group for the purpose of reducing anxiety.

MARS refers to the full-version of the mathematics anxiety rating scale developed by Richardson and Suinn (1972) for use on college age samples.

Non-journal writer refers to the control group; that is, the group of students who did not participate in the journal-writing program.

Prerequisite course refers to the third and final part of the developmental, mathematics sequence of courses at a particular South Texas community college.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This review of literature will focus on two principal areas. They are: (1) causes of mathematics anxiety, and (2) misconceptions about mathematics and mathematicians. Suggestions and/or examples for dealing with mathematics anxiety will be discussed within each topic.

Criterion Traits Associated with Mathematics Anxiety

Researchers have not yet developed an exact list that explicitly defines mathematics anxiety or any traits associated with this condition. However, there is a general consensus on some of the most common criterion traits associated with mathematics anxiety. The traits associated with mathematics anxiety are diverse. Some of the most common ones are: nausea, a hot tingling feeling, extreme nervousness, an inability to hear the teacher, a tendency to become upset by noises, an inability to concentrate, negative self-talk, stomach aches, sweaty palms, panic, tension, a feeling of helplessness, fear, distress, feelings of shame, and an inability to cope (Buxton, 1981; Clawson, 1991; Kogelman & Warren, 1978; Richardson & Suinn, 1972). This phobia may originate with students' lack of preparation, not attending classes on a regular basis, having negative experiences with teachers or parents, or not being able to relate mathematics to the real world (Godbey, 1997).

Mathematics Anxiety among Parents, Teachers, and Elementary Education Majors

A credible cause of mathematics anxiety can be traced to early experiences at home and in school. Mathematics anxiety should be a concern with schools, classrooms, parents, and teachers. Students may see their teachers and parents as authority figures and may try to emulate them (Buxton, 1981). Some parents may feel that they never really understood mathematics thus making an excuse for their child's substandard mathematical performance. A parent who has experienced mathematics anxiety will likely pass this phobia on to their child (Fiore, 1999; Hembree, 1990; Williams, 1988).

Students spend one third of their day in the classroom. Surely, the time spent there influences the student. Teachers must remember that they are role models for students. As such, they should strive to create a positive learning environment. Many people report that they fear mathematics particularly because of negative experiences with past teachers (Fiore, 1999). The sad part is that mathematics anxiety can actually be "learned" from these teachers.

Teachers, especially at the elementary level, are one of the major sources for the spread of mathematics anxiety to students (Buxton, 1981; Fiore, 1999; Hembree, 1990; Jackson & Leffingwell, 1999; Martinez, 1987; Williams, 1988). One of the possible reasons is that elementary education teachers usually report higher levels of mathematics anxiety than educators at other levels do (Fiore, 1999; Levine, 1996; Trent, 1987; Williams, 1988). In turn, this may lead teachers to question their effectiveness in teaching mathematics lessons (Ho et al., 2000; Levine, 1996; Trice & Ogden, 1986). Consequently, their attitudes towards mathematics may begin to take on a negative role.

This can severely influence students, as teacher attitudes are directly linked to student performance and student attitudes toward mathematics (Scholfield, 1981). Some of these students may eventually become teachers and continue the horrid cycle of passing on their legacy of mathematics phobia (Nicol, 1999). This may help account for the multitudes of people who identify themselves as having mathematics anxiety.

Another contributing factor to mathematics anxiety could be the methods, or lack thereof, used to teach the subject (Stodolsky, 1985). For example, some teachers may expect students to perform calculations at lightning speeds. This time pressure in performing mental arithmetic can impede the learning process (Buxton, 1981). Also, traditional pedagogy and "reform" mathematics, i.e., memorizing vs. learning, and remembering vs. understanding, is an area where further research may help to differentiate the positive and negative aspects associated with each area. Students seem to be taught to memorize and remember rather than to learn and understand. This causes a lot of anxiety for students because they are just repeating formulas and numbers without actually knowing the significance of their responses (Buxton, 1981; Gordon, 1998; Greenwood, 1984; McCoy, 1992).

Some students seem to have a love for mathematics, whereas other students may not even know how mathematics can play a role in their lives. Mathematics anxiety can be described as more a dislike towards the subject than a lack of mathematical ability (Vinson, Haynes, & Gresham, 1997). Mathematics anxiety is a frequently used excuse by students to explain their poor performance on mathematics tests (Betz, 1978; Resnick, Viehe, & Segal, 1982). A common notion about achievement is that success will come if a person works hard enough (Johnson, 2000). Students with positive attitudes towards mathematics usually will learn the subject (Cooper & Robinson, 1991; Kogelman & Warren, 1978). Thus, attitude may actually be as important as aptitude.

Effective Teachers

It is unfortunate that some teachers, nowadays, are more concerned about students feeling good and having fun in class rather than actually learning mathematics. The reality is that mathematics performance is not related to students having “fun” in class (Dew, Galassi, & Galassi, 1984; Llabre & Suarez, 1985). The effective teacher is the one with the highest educational standards. “Educators can contribute to minority students’ academic and personal success simply by communicating high expectations” (Hrabowski, 2003, p. 47). High achieving teachers with a strong command of their content and pedagogy tend to produce high achieving students with the least favorable attitudes towards mathematics. On the other hand, average or low achieving teachers who may have less command of their content and pedagogical skills may produce students whose attitudes towards mathematics are the most favorable, but who maintain the lowest achievement scores (Cruikshank & Sheffield, 1992; Scholfield, 1981). “Ask yourself: Who would you prefer to have operating on you—a surgeon driven by perfectionism or one taught through the years that exactitude isn’t everything, and that even the most miserable performance is worth a gold star and a hug?” (Snow, 2001, Conclusion section, para. 13).

Journal Writing

When the National Council of Teachers of Mathematics released its Curriculum Standards for Grades 9-12 it stated that communication, both orally and written, should play a bigger role in a mathematics classroom (NCTM, 2000, p. 347). As found in Rab (2000), the Curriculum Standards state that:

> All students need extensive experience listening to, reading about, writing about, speaking about, reflecting on, and demonstrating mathematical ideas…Teachers [should] direct instruction away from a focus on the recall of terminology and routine manipulation of symbols and procedures toward a deeper conceptual understanding of mathematics. It is not enough for students to provide the answer to an exercise or even to "show all their steps." It is equally important they be able to describe how they reached an answer or the difficulties they encountered while trying to solve a problem. Continually encouraging students to clarify, paraphrase, or elaborate is one means by which teachers can acknowledge the merit of students' ideas and the importance of their own language in explaining their thinking (p. 1).

Research on journal writing in mathematics classrooms is difficult to analyze due to a multitude of factors. Nonetheless, researchers from the United States Air Force Academy were able to "demonstrate journal writing's direct, positive impact on students' test-taking success…they sought to demonstrate that extensive journal writing on a specific topic could be directly linked to success answering test problems concerning that topic" (Rab, 2000, p. 3). The results of the study showed that students who wrote in journals had a deeper understanding of the subject.

Similarly, Cai & Kenney (2000) were able to conclude that communication in mathematics is essential for learning, doing, and understanding mathematics. They reported that students should be able to express their thinking and problem-solving processes in both written and oral formats if they wish to truly understand the subject. It seems that writing in a mathematics journal compels students to "teach" themselves. This relates to the expression that a person can learn something when they have to teach it to others.

Furthermore, journal writing can be implemented by teachers in order for students to

> express their understanding of mathematical concepts or to share feelings about and experiences with math…this technique allows teachers to get a better understanding and feel for any frustration students are experiencing…[it] also serves as an alternative form of assessment [because] a teacher can read through the journals to determine if a student understands the mathematical concepts being taught (Furner & Duffy, 2002, p. 70).

Teaching Strategies

One helpful teaching strategy is using problems that are counterintuitive. These are problems where "answers and solutions…may not, at first, seem right to students or adults" (Maylone, 2000, p. 542). "Using counterintuitive mathematics problems helps to keep adolescent students actively involved in their mathematics education" (Maylone, 2000, p. 542).

Certainly, any method cannot be effective until and unless students have a strong foundation. After all, without a strong support system nothing will endure. At Kean University in New Jersey, a special program patterned after a workshop created by Dr. Phillip Uri Treisman is offered for students interested in having a deeper understanding of mathematics. The courses are open to all students, but minority students are especially urged to participate (Goldberg & Hahn, 2000). The basic layout of the courses, which range from College Algebra through Calculus, is that they meet four times a week. The days are split evenly so that lectures are twice a week and the other two days are devoted to problem solving activities. Other prestigious colleges such as the University of Texas at Austin, the University of California at Berkeley, and Rutgers University are offering similar courses. Participants in the Kean program are told, "…students in these programs do much better in their math classes and develop greater enthusiasm to study mathematics" (Goldberg & Hahn, 2000, p. 84). In addition, the majority of students in these courses earn A's or B's. Mathematics is a discipline that must be practiced consistently. The students at Kean are afforded an excellent opportunity for success.

Teachers can drill students on the foundation of mathematics, but if the students cannot understand how to apply the mathematics then the whole process fails. Conversely, if the students understand the mathematics but cannot perform simple operations, this, too, fails. The only way we can ensure mathematical success for students is for them to know and apply. These skills are interconnected. One cannot hope to proceed until there is mastery of the basic skills.

At other times, it is the fluency in executing a basic skill that is essential for further progress in the course of one's mathematical education. The automaticity in putting a skill to use frees up mental energy to focus of the more rigorous demands of a complicated problem (Wu, 1999, p. 16).

Another strategy for teaching mathematics is to use manipulatives in the classroom. They help by "opening" the eyes of students and making mathematics seem like a more concrete rather than abstract concept (Godbey, 1997). This may also help students feel more relaxed in the class environment thus lowering their levels of mathematics anxiety.

International Curriculum

In contrast to the American way of teaching mathematics, the Japanese work under a national curriculum. Japan is consistently ranked among the top five countries in the world in terms of mathematics scores on standardized tests (Gonzales et al., 2004). They follow a "less is more" philosophy that puts a greater emphasis on understanding and conceptualizing. The Japanese mathematics educators are willing to experiment on new styles of teaching whereas the "Americans often lack the patience to achieve" (Coeyman, 2000, p. 2). In addition, the Japanese believe in a strong research and development program for studying different teaching methods (Coeyman, 2000). This trend seems to be the norm for Asian countries. According to Sun (1998), Asian-American students tend to outperform students from other race-ethnic backgrounds. The author indicates that East Asians invest more aggressively in financial, human, and within-family social capital. Perhaps, this topic should be explored further by researchers in the United States.

If the United States hopes to be considered as one of the top ten countries in terms of standardized math test scores, the standards and the expectations of students need to be raised significantly. For example, according to the website Japanese-Online (2000), all Japanese 12-year-olds are given standardized mathematics tests and are expected to solve each problem within two minutes. The problems posed seem to involve a deep understanding of mathematics. On the website Glen Learning Technologies Project (2000), examples of the standardized test administered by the state of Ohio for ninth graders, traditionally 14-year-olds are given. It is apparent that these problems are relatively easy when compared to the Japanese problems.

Domestic Curriculum

To further illustrate the issue of low expectations, consider the Texas Assessment of Academic Skills (TAAS) test. This was a test that all public school students in the state of Texas needed to pass in order to graduate. The sad reality is that the mathematics portion of the test measured abilities at an eighth grade level (Tapia & Lanius, 2000). These types of tests are instilling a false sense of knowledge in our students, and the blame should be placed on the educational system for its lack to even attempt to solve this problem. It is obvious that we must raise the level of expectations for our students. Fortunately, the state of Texas moved towards a better accountability system with the introduction of the “revised” TAAS now known as the Texas Assessment of Knowledge and Skills (TAKS). It is yet to be seen whether or not this will more accurately reflect a student's grasp of the mathematics strand.

Varieties of teaching methods have been and will always be available for individuals to consider. Methods from other countries with different cultures may or may not be effective in the United States; however, we are free to modify and adapt them to meet our needs. In addition, patience is a trait that must be developed. If at first we do not succeed, we need to try again; the same philosophy applies to new ideas. It is imperative that if we decide to use an innovative idea for teaching mathematics, time must be given so that it can flourish. Ultimately, the effect of the methods used will rely more on the teacher than on the method itself.

Mathematics Fears and Their Limitations

The word "mathematics" strikes fear in many people. This fear may be rooted in the belief that mathematics deals with abstract, rather than concrete ideas, because differences exist between symbols and mathematical concepts (Buxton, 1981), or because students do not see the connection to the real world. This panic can have a serious effect on the lives of people. The unwillingness to take advanced mathematics classes severely limits the choice of majors' available (Chipman, Krantz, & Silver, 1992; Richardson & Suinn, 1972) and effectively shuts them out of many possible career opportunities. This is especially true for females (Campbell & Evans, 1997; Dutton & Dutton, 1991; Resnick et al., 1982; Reyes, 1980). Students who pass advanced mathematics courses earn significantly higher salaries than those who choose not to enroll in similar classes.

Males vs. Females

Throughout history, mathematics has usually been thought of as a male dominated and male oriented subject (Kogelman & Warren, 1978). This view may negatively affect females and their possible mathematical success. They may tend to show disinterest in mathematics because of its strong association with masculinity (Tobias, 1978). The perception continues today and could be used to explain why females usually report a higher level of mathematics anxiety than males (Betz, 1978; Buxton, 1981; Hembree, 1990; Llabre & Suarez, 1985; Ruben, 1998). Ironically, research indicates that there is little or no evidence to show that males do better than females in terms of mathematics achievement (Gliner, 1987; Hembree, 1990; Ma, 1999).

Additionally, there are large numbers of females whose fathers are in jobs requiring an extensive knowledge of mathematics, such as mathematics professors, engineers, architects, and others. However, the daughters, who also have a mathematics aptitude, may not want to identify with their fathers. The females may go to great lengths to deny their interest in mathematics because of its perceived association with masculinity (Tobias, 1978). One possible way to encourage females and minorities to pursue careers in the mathematical sciences is to invite individuals who have achieved success through mathematics to speak in the classroom and demonstrate that anyone can be proficient in mathematics.

Mathematics Anxiety vs. Mathematics Performance

Students always look for ways to explain poor performances on mathematics exams; therefore, mathematics anxiety is a frequently used excuse (Betz, 1978; Resnick et al., 1982). Some research suggests that the two constructs are moderately related by an inverse relationship (Betz, 1978; Dew et al., 1984). In addition, the results of a meta-analysis of 151 studies suggest that mathematics anxiety is related to mathematics achievement (Hembree, 1990). Furthermore, "treatments that resulted in significant mathematics anxiety reduction were accompanied by significant increases in mathematics test scores" (Hembree, 1990, p.43).

Along with seminars on reducing mathematics or test anxiety, students need to take courses that focus on improving or relearning fundamental mathematical skills. Furthermore, since verbal skills are good predictors of overall mathematics achievement in high school (Gliner, 1987), school districts should emphasize reading and comprehension programs, with mathematics teachers focusing on reading and understanding of words and symbols in mathematics.

Students' Feelings about Mathematics

One possible cause of mathematics anxiety is the students' unwillingness to like the subject. Mathematics anxiety is more a dislike towards the subject than it is a lack of ability (Vinson et al., 1997). Mandating students to take more mathematics classes in high school can help alleviate this problem. In turn, they will be better prepared to succeed in mathematics courses when they go to college (Betz, 1978). Students with positive attitudes who believe they can learn mathematics usually will learn mathematics (Cooper & Robinson, 1991). Mathematics seems to be more a question of attitude, not aptitude (Kogelman & Warren, 1978). Teachers, whether knowingly or unknowingly, pay more attention to students who are sure of themselves and their mathematical abilities. This may result in teachers helping the "smarter" students succeed, while at the same time, it may result in teachers not encouraging those students who can succeed, if they are just afforded more attention.

Myths

One myth concerning mathematicians is that they are geniuses, cold, withdrawn, and introverted (Kogelman & Warren, 1978). Many people believe they cannot relate to "these" types of people. In addition, there are many myths about mathematics that need to be conquered, among them are:

> (a) men are better in math than women, (b) math requires logic, not intuition, (c) you must always know how you got the answer, (d) math is not creative, (e) there is a best way to do a math problem, (f) it's always important to get the answer exactly right, (g) it's bad to count on your fingers, (h) mathematicians do problems quickly, in their heads, (i) math requires a good memory, (j) math is done by working intensively until the problem is solved, (k) some people have a "math mind" and some don't, and (l) there is a magic key to doing math (Kogelman & Warren, 1978, p. 30-43).

Teachers need to help students demolish the 12 myths stated above. Some possible suggestions that can be implemented are listed below.

Educators should divide their attention equally between males and females. For example, pile a set of colored note cards on a desk: one blue card for each male student, and one pink card for each female student. Remove the appropriate color note card after each question asked. This helps ensure that attention and interest is evenly divided between males and females.

Tell students about personal experiences in trying to solve mathematical problems. Students should realize that a lot of time may be spent trying to understand and solve a problem and it is quite normal to feel overwhelmed with the task. A quick story about personal frustrations may help students relax and feel better about their frustrations with mathematics. Students should know that this is a common situation for all people studying mathematics.

Do not punish students if they can solve problems in a unique manner. Each person solves problems in their own way. Mathematics problems should be "attacked" from different angles. There are different styles of learning and just as many ways to work out mathematics problems. For example, some students may have to plot points in order to graph the parabola $y = x^2+3$, whereas other students feel more comfortable shifting the basic equation, $y = x^2$, three units up. Students may feel that there is only once correct way to arrive at a solution. They should be taught that one approach is not necessarily better than the other one, if both ways yield the same result.

There are instances when approximations are valuable. For instance, graphs are useful in visualizing and interpreting data, and making general observations. However, it is not necessary to have exact points on the graph. Similarly, when trying to calculate the distance between two towns it is not necessary to have such a high level of precision when the only question that needs to be addressed is "How long will the trip last?"

Additionally, educators should allow students to work problems in a reasonable time frame. Educators should remember their own experiences in solving mathematical problems. Aside from basic arithmetic tasks, it is uncommon to expect students to solve meaningful problems in a relatively small amount of time.

Teacher's Role in Overcoming Mathematics Anxiety

Teachers should maintain a positive attitude towards mathematics and help students understand that mathematics is a subject that can be mastered by all. In particular, according to Suydam (1984, p.12), teachers can develop and maintain positive attitudes toward mathematics by:

> (a) showing that you [they] like mathematics, (b) making mathematics enjoyable so that children develop positive perceptions of mathematics and of themselves in relation to mathematics, (c) showing that mathematics is useful in both careers and everyday life, (d) adapting instruction to students' interests, (e) establishing short-term goals that students have a reasonable chance of attaining, (f) providing experiences designed to help children be successful in mathematics, and (g) showing that mathematics is understandable by using meaningful methods of teaching.

Student's Role in Overcoming Mathematics Anxiety

Along with the teacher, a student needs to contribute to his or her education. A teacher can only do so much. Students need to ultimately play an active role in learning mathematics. Teachers should inform students that mathematics anxiety is normal. In addition, mathematics educators ought to provide a copy of the following mathematics anxiety bill of rights to their students:

> (a) I have the right to learn at my own pace and not feel put down or stupid if I'm slower than someone else, (b) I have the right to ask whatever questions I have, (c) I have the right to need extra help, (d) I have the right to ask a teacher or TA for help, (e) I have the right to say I don't understand, (f) I have the right not to understand; (g) I have the right to feel good about myself regardless of my abilities in math, (h) I have the right not to base my self-worth on my math skills, (i) I have the right to view myself as capable of learning math, (j) I have the right to evaluate my math instructors and how they teach, (k) I have the right to relax, (l) I have the right to be treated as a competent adult [person], (m) I have the right to dislike math, and (n) I have the right to define success in my own terms (Tobias, 1978, p. 236-237).

If students are made aware that mathematics anxiety is normal, then they might feel a little more relaxed in dealing with the subject in light of their levels of anxiety.

Suggestions for Dealing with Mathematics Anxiety

Why do so many students fear mathematics? The answer is probably because it is not an easy subject and students do not want to spend their time learning it. There are things that can be done to overcome this fear. For example, students should empower themselves to ask questions in class and sit towards the front of the classroom. In addition, teachers can help students understand that when reading mathematics textbooks, it is best to read one part at a time until it is fully understood. Likewise, students should do more engaged homework so they can become proficient (Tobias, 1978). Next, teachers should not lower standards; rather, they should expect only the best from their students. School districts should give teachers more time to prepare lessons and provide relevant in-service programs (Trent, 1987). Colleges and universities should have mathematics standards for future teachers to ensure that future educators are sufficiently competent in the content area (Dossey, 1981; Trent, 1987). Additionally, advanced degrees need to be offered, especially for middle school/junior high school mathematics teachers (Trent, 1987). Workshops emphasizing topics such as study skills, time management, and mathematics anxiety management should be provided (Seon & King, 1997). Finally, students need to develop a positive attitude. Parents and teachers need to unite to help students understand that mathematics plays a large role in today's society. This is one of the most important factors in learning mathematics (Cooper & Robinson, 1991; Kogelman & Warren, 1978).

Summary

To sum up, there are many causes of mathematics anxiety. One of the major sources is attributed to teachers, who pass on their own anxieties to their students. Unfortunately, some of these children may become educators, and continue the cycle of passing on mathematics anxiety. Additionally, teachers seem to care more about a student feeling good than they are with a student learning the basic skills. In other words, some teachers may be producing students capable of taking tests and doing calculations, but not capable of understanding what they are doing.

It should be noted that average or low achieving teachers (i.e., teachers who have less command of their content or pedagogical skills) tend to produce students with the most favorable attitudes towards mathematics, but with the lowest achievement scores. In addition, some teachers are not encouraging students to take advanced mathematics classes. This can severely limit the students' choice of major and careers in the future.

Furthermore, the misconception that females are not supposed to excel in mathematics adds extra anxiety to these students. Another root of mathematics anxiety seems to rest with the students' parents, who can also pass on their phobias to their children. If teachers feel a need to reduce mathematics anxiety among students, then they should help students understand that mathematics is like a language. It takes effort and time to understand. In conclusion, the most important factor influencing mathematics performance is attitude, not aptitude. Students who develop a positive attitude and thus have minimal levels of mathematics anxiety are the ones who will ultimately succeed in the subject.

- One important thing to remember about mathematics anxiety is that:

> Although the condition is not a pleasant one, it does have two positive facets: it is curable at any stage, and its hold is never irreversible. The first step, however, is to admit that the anxiety exists…it is important to understand that there is nothing shameful in admitting to being math anxious (Burton, 1979, p. 130).

CHAPTER III

METHODOLOGY

Background of the Study

This study is part of the ongoing efforts of mathematics educators to help students, in particular Hispanic/Latino pupils, succeed in the mathematical fields. There has been much research published on mathematics anxiety with respect to students from Anglo populations and a fair amount of research concerning minorities (mainly females and/or African Americans). However, there seems to be minimal work focusing solely on Hispanic/Latino students enrolled in community colleges.

In order to improve the levels of technology required for furthering the role of the United States as a leader in the world it is necessary to have citizens who can reason mathematically as well as be able to use critical thinking skills to solve problems. In addition, the U.S. should promote the further education of Latino/Hispanic individuals so that it is not only the Anglo citizens participating in this worthy endeavor. This group was targeted partially because “one of every seven people in the United States is Hispanic, a record number that probably will keep rising because of immigration and a birth rate outstripping that of non-Hispanic blacks and whites” (Hispanics now, 2005, Introduction section, para. 1). With this in mind, this study focused on possible ways to improve the mathematical abilities of Latino/Hispanic college students.

Participants and Setting

This quantitative study was conducted during the last five weeks of the spring 2004 semester at a predominantly Hispanic/Latino South Texas community college. The following tables show the student demographic information for this community college. Table 1 shows the number of students enrolled in the community college by gender and enrollment status, the type of major they have declared, the students' age group, and the ethnic breakdown of the population of this particular community college.

Table 1. Population Demographics

	Male		Female		Total	
Enrollment	Number	Percent	Number	Percent	Number	Percent
Full-Time	1,059	14.40	1,291	17.56	2,350	31.96
Part-Time	1,983	26.97	3,019	41.06	5,002	68.04
Total	3,042	41.38	4,310	58.62	7,352	100
Major						
Academic	1,370	18.63	2,295	31.22	3,665	49.85
Vocational	1,250	17.00	1,654	22.50	2,904	39.50
Tech-Prep	422	5.74	361	4.91	783	10.65
Age						
Under 18	4	0.05	12	.16	16	0.21
18-20	859	11.68	1,212	16.49	2,071	28.17
21-25	1,319	17.94	1,608	21.87	2,927	39.81
26-30	347	4.72	504	6.86	851	11.58
31-40	311	4.23	586	7.97	897	12.20
Over 40	202	2.75	388	5.28	590	8.03
Ethnicity						
Latino/Hispanic	2,841	38.64	4,102	55.79	6,943	94.43
White, Non-Hispanic	63	0.86	68	0.92	131	1.78
International	119	1.62	114	1.55	233	3.17
Asian or Pacific Islander	9	0.12	10	0.14	19	0.26
Black, Non-Hispanic	10	0.14	7	0.10	17	0.24
American Indian	0	0.00	4	0.05	4	0.05
Unknown or Not Reported	0	0.00	5	0.07	5	0.07

Table 2 shows the number of disadvantaged students at this community college. Table 3 shows the passing rate for the on-campus college algebra students during the semester when the study was conducted.

Table 2. Number and Percentage of Disadvantaged Students by Gender

	Male		Female		Total	
Type of Disadvantage	Number	Percent	Number	Percent	Number	Percent
Academic	1,824	24.81	2,708	36.83	4,532	61.64
Economical	1,731	23.54	2,889	39.30	4,620	62.84
Disabled	38	0.52	37	0.50	75	1.02
Limited English Proficiency	1,764	23.99	2,629	35.76	4,393	59.75
Displaced Homemaker	3	0.04	37	0.50	40	0.54
Single Parent	3	0.04	43	0.58	46	0.62

Table 3. Spring 2004 Enrollment and Grade Distribution for On-Campus College Algebra (MATH 1314)

Grade	Number	Percent
A	117	17.21
B	118	17.35
C	147	21.62
D	61	8.97
F	56	8.24
I	4	0.59
W	177	26.03
No. of Sections	23	100
Total Students	680	100

Students from eight sections of a college algebra course that met on a Monday-Wednesday-Friday schedule were asked to volunteer for the study. A convenience sample was used for this research because of the availability of the participants and its effectiveness in helping to provide an understanding of existing relationships (McMillan, 2000). Volunteers were asked to sign a consent form (See Appendix A-Consent Form). Initially, there was a total of $N = 197$ participants. However, some participants did not meet the age requirements, were not from the ethnic background being studied, did not participate in the study, or withdrew from the class before the study was completed.

They were subsequently excluded from data analysis. Thus, the study was conducted with a sample size of $N = 123$. Participants consisted of Hispanic/Latino students ranging in ages from 18-25.

The instructors participating in this study had at least a master's degree with 18 graduate hours in mathematics and met the minimum requirements set forth by the Texas Higher Education Coordinating Board for teaching college-level courses at a community college. Their style of teaching consisted primarily of direct instruction as opposed to constructivist theories. That is, instruction consisted mainly of providing examples of problems and then explaining how to solve them. Students were mostly passive rather than active participants in the learning process.

Instrumentation

The instrument used to assess the levels of mathematics anxiety was the 98-question *Mathematics Anxiety Rating Scale* (MARS) developed by Richardson & Suinn (1972). The MARS has been shown to have an internal consistency of $\alpha = 0.97$ with a seven week test-retest reliability of $r = 0.85$ (Richardson & Suinn, 1972). The internal consistency of the MARS for the pretest/posttest portions of the study were $\alpha = 0.98$ and $\alpha = 0.99$, respectively. The test-retest reliability of the MARS for the study was $r = 0.87$.

The mathematics achievement test consisted of 48 problems from the Texas Higher Education Assessment (THEA) practice test (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002). The test, formerly named Texas Academic Skills Program (TASP), covers basic college-level mathematical knowledge (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).

> The purpose of the test, which was developed to support the goals of the Texas Academic Skills Program, is to assess the reading, mathematics, and writing skills first year students should have if they are to perform effectively in undergraduate certificate or degree programs in Texas public colleges and universities. The skills listed below are eligible to be assessed by the TASP Test. The Mathematics section of the TASP Test consists of approximately 50 multiple-choice questions covering four general areas: fundamental mathematics, algebra, geometry, and problem solving. The test questions focus on a student's ability to perform mathematical operations and solve problems. Appropriate formulas are provided to help examinees perform some of the calculations required by the test questions. (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).
>
> - The fundamental mathematics strand:
>
> Includes solving word problems involving integers, fractions, decimals (including percents), ratios and proportions, and units of measurement and conversions (including scientific notation). [It also] includes interpreting information from line graphs, bar graphs, pictographs, and pie charts; interpreting data from tables; recognizing appropriate graphic representations of various data; analyzing and interpreting data using measures of central tendency (mean, median, and mode); and analyzing and interpreting data using the concept of variability. (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).
>
> - The algebra strand:
>
> Includes identifying the graph of a given equation or a given inequality; finding the slope and/or intercepts of a given line; finding the equation of a line; and recognizing and interpreting information from the graph of a function (including direct and inverse variation). [It also] includes finding the value of the unknown in a given one-variable equation, expressing one variable in terms of a second variable in two-variable equations, and solving systems of two equations in two variables (including graphical solutions). [Also] identifying the algebraic equivalent of a stated relationship and solving word problems involving one and two unknowns. [In addition to] factoring quadratics and polynomials; performing operations on and simplifying polynomial expressions, rational expressions, and radical expressions; and applying principles of functions and functional notation. [Lastly] graphing quadratic functions and quadratic inequalities; solving

quadratic equations using factoring, completing the square, or the quadratic formula; and solving problems involving quadratic models. (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).

- The geometry strand:

Includes solving problems involving two-dimensional geometric figures (e.g., perimeter and area problems) and three-dimensional geometric figures (e.g., volume and surface area problems), and solving problems using the Pythagorean Theorem. [Also] solving problems using principles of similarity, congruence, parallelism, and perpendicularity. (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).

- The problem-solving strand

Includes drawing conclusions using inductive and deductive reasoning. [As well as] applying combinations of mathematical skills to solve problems and to solve a series of related problems. (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).

The TASP skills and item specifications were developed and approved by committees of Texas faculty in community colleges and universities. The skills were validated in surveys of Texas educators and were finalized for testing by the test development committees. The committees then reviewed and validated test items. The test items were pilot-tested in Texas and finalized by the committees based on pilot test results. Independent panels of Texas higher education faculty reviewed and revalidated the items and provided input to the Texas Higher Education Coordinating Board (THECB) and the State Board of Education for use in setting passing standards. These boards are responsible by law for setting the passing standards. (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).

The reliability estimate for the TASP/THEA test is "provided by the Kuder-Richardson index of item homogeneity (KR-20)." (Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002). Data were taken from the 1998-1999 testing year. Table 4 summarizes this data.

Table 4. TASP/THEA Mathematics Results for 1998-1999

Statistic	Mathematics Portion of Test
Number of scorable items	48
Mean percent correct	54.5–58.1
Mean raw score	26.0–27.9
Standard deviation	7.0–7.9
Standard error of measurement	3.1
KR-20 reliability	0.80–0.85

(Texas Higher Education Coordinating Board and National Evaluation Systems, Inc., 2002).

A survey was developed to better understand the participants' background. The survey asked for participants' sex, age range, country of high school completion, type of high school attended, and family economic background (See Appendix B-Mathematics Anxiety Survey).

Data Collection

Data collected for each participant included the background information survey, final numerical grade for the class, mathematics writing journals (for the experimental group), MARS, and THEA mathematics achievement test. Participants were assigned a number to write on the consent form, survey, MARS, and THEA to ensure that the data collected represented the same participants throughout the study. The Mathematics

Anxiety Rating Scale (MARS) was distributed to each participant two days (one class meeting) before administration of the mathematics achievement test. Participants were allowed 50 minutes (one class meeting) to complete the THEA assessment.

The scores on the MARS were used to determine the participants' reported level of mathematics anxiety, while the scores on the THEA were used to measure mathematical achievement. After the four-week experimental phase, participants were re-administered the MARS. Two days (one class meeting) later, participants were re-administered the THEA practice test. Data were inputted into SPSS and subsequently verified for accurateness by having an independent individual cross check the data.

Procedure

After the first round of the MARS and THEA distributions, the class sections were randomly designated as either experimental or control groups. There were $N = 24$ males (19.51%) participating in the experimental group and $N = 24$ (19.51%) males participating in the control group. There were $N = 40$ (32.52%) females participating in the experimental group and $N = 35$ (28.46%) females participating in the control group.

Tables 5-8 provide background and demographic information about the participants in the experimental and control groups. Table 5 shows the number of participants by group (control/experimental) and age. Table 6 shows the country of high school graduation according to gender and group. Table 7 shows the type of high school (public/private) where each participant graduated from. Table 8 shows the family's background (blue-collar/white-collar) for the participants.

Table 5. Number of Participants by Group and Age

	Male				Female			
	18-21		22-25		18-21		22-25	
	#	%	#	%	#	%	#	%
Experimental	19	15.45	5	4.10	35	28.46	5	4.10
Control	22	17.89	2	1.63	31	25.20	4	3.25

Table 6. Country of High School Completion by Gender and Group

	Male				Female			
	U.S.		Mexico		U.S.		Mexico	
	#	%	#	%	#	%	#	%
Experimental	20	16.26	4	3.25	37	30.08	3	2.44
Control	24	19.51	0	0.00	31	25.20	4	3.25

Table 7. Type of High School Attended by Gender and Group

	Male				Female			
	Public		Private		Public		Private	
	#	%	#	%	#	%	#	%
Experimental	21	17.07	3	2.44	37	30.08	3	2.44
Control	24	19.51	0	0.00	31	25.20	4	3.25

Table 8. Family Background by Gender and Group

	Male				Female			
	Blue-collar		White-collar		Blue-Collar		White-Collar	
	#	%	#	%	#	%	#	%
Experimental	14	11.38	10	8.13	26	21.14	14	11.38
Control	17	13.82	7	5.69	22	17.89	13	10.57

The experimental class participated in a mathematics journal-writing project during the last five minutes of each class meeting. The daily journal-writing prompt instructed participants to think about the day's lecture and write down their feelings about what they did or did not learn, any difficulties they had understanding the instructor, or about any fears or anxieties they were experiencing in the class. Participants were asked to avoid just summarizing the lecture of the day. In addition, they were asked to keep the length of the journal to a maximum of one page. No minimum length was suggested. The control group continued with their regular class lectures and/or activities. This process continued for four weeks.

CHAPTER IV

RESULTS

The goals of this study were: (1) to determine if there exists a statistically significant difference in reported levels of mathematics anxiety between Hispanic/Latino male and female students enrolled in college algebra courses at a predominantly native Spanish speaking South Texas community college, (2) to determine if there exists a statistically significant relationship between a person's reported level of mathematics anxiety and their performance on a mathematics test, (3) to determine to what extent, if any, gender plays a role in success on mathematics tests for higher education students, (4) to determine if students that participate in a journal-writing program experience a statistically significant change in their reported levels of mathematics anxiety, and (5) to determine if there exists a statistically significant difference in performance on mathematics tests between students who participate in a journal-writing program and those who do not participate in the program.

This study was conducted during the last five weeks of the spring 2004 semester at a predominantly Hispanic/Latino South Texas community college. The focus was on Hispanic/Latino students ranging in ages between 18-25. A total of $N = 123$ participants from six sections of a college algebra course that met on a Monday-Wednesday-Friday schedule volunteered for the study. This chapter focuses on the analysis for the data provided.

Data Analysis

A few participants did not answer some questions on the MARS so the missing data points had to be replaced. A crosstabs operation was performed on the missing data points to see if any patterns emerged regarding questions being intentionally left blank. The pre-MARS had a maximum of two questions left unanswered, while the post-MARS had a maximum of three questions left unanswered. Since there were no signs of a pattern, the decision was made to replace the missing values using SPSS imputation algorithm. The internal consistency of the MARS for the pretest/posttest portions of the study before the missing data were replaced were $\alpha = 0.98$ and $\alpha = 0.99$, respectively.

The first method used to replace the missing values was the "linear trend at point" option. This is the most powerful option with the highest assumption levels. It "replaces [the] missing values with the linear trend for that point… [and the] missing values are replaced with their predicted values" (SPSS, 2003, p. 152). The internal consistency of the MARS for the pretest/posttest portions of the study using this option were $\alpha = 0.98$ and $\alpha = 0.99$, respectively.

The second method used to replace the missing values was the "series mean" option. This is the least powerful option with the lowest assumption level. It "replaces the missing values with the mean for the entire series" (SPSS, 2003, p. 151). The internal consistency of the MARS for the pretest/posttest portions of the study using this option were $\alpha = 0.98$ and $\alpha = 0.99$, respectively.

These methods show that the predicted values and the mean of the scores were not really statistically different from the actual student choices. Thus, the more powerful "linear trend at point" option was selected to replace the missing values.

Effect sizes for *t*-tests are reported as Cohen's *d* and were determined by computing the difference between the two means divided by the pooled standard deviation. Effect sizes for ANOVA results were computed using partial eta squared (η_p^2). Effect sizes for regression analysis were computed using adjusted *R squared* (R^2).

Mathematics Anxiety and Gender

The first research question asked, "Does there exist a statistically significant difference in reported levels of mathematics anxiety between Hispanic/Latino male and female students enrolled in college algebra courses at a predominantly native Spanish speaking South Texas community college?" It was hypothesized that males would be more likely to report lower levels of mathematics anxiety when compared to females. An independent *t* test was calculated comparing the mean mathematics anxiety scores for males and females on the first administration of the MARS. Alpha was set at *0.05*. The pretest mean for males ($m = 238.09$, $sd = 73.08$) was not statistically different from the mean for females ($m = 236.56$, $sd = 62.91$), therefore the unadjusted posttest scores were used to test the hypothesis. The results are summarized in Tables 9, 10, and 11. Table 9 shows the pre and posttest means of the participants' reported levels of mathematics anxiety along with the effect sizes. Table 10 shows the results of the ANOVA for the MARS pretest, and Table 11 shows the results of the ANOVA for the MARS posttest.

Table 9. MARS Pretest and Posttest Means by Gender

MARS	Gender	N	M	SD	*SEM*	*d*
Pretest	Male	48	238.09	73.08	10.55	0.02
	Female	75	236.56	62.91	7.26	
Posttest	Male	48	227.35	75.30	10.87	0.02
	Female	75	226.12	73.68	8.51	

Table 10. ANOVA Summary Table for MARS Pretest Scores by Gender

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Between groups	1	69.27	69.27	0.02	0.90	0.00
Within groups	121	543903.40	4495.07			
Total	122	543972.70				

Table 11. ANOVA Summary Table for MARS Posttest Scores by Gender

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Between groups	1	44.49	44.49	0.01	0.93	0.00
Within groups	121	668229.50	5522.56			
Total	122	668274.00				

The mean for males *(m = 227.35, sd = 75.30)* was not statistically different from the mean for females *(m = 226.12, sd = 73.68)* on the MARS posttest means $t\ (121) = 0.09$, *n.s.*, $d = 0.02$. The effect size of *0.02* further complements the assumption that males and females do not differ in their reported levels of mathematics anxiety. The hypothesis was not supported in this study.

Mathematics Anxiety vs. Mathematics Achievement

The second research question asked, "Does there exist a statistically significant relationship between a person's reported level of mathematics anxiety and their performance on mathematics tests?" It was hypothesized that mathematics anxiety and mathematics achievement, as measured on a mathematics test, would be inversely related. A simple linear regression was calculated to predict the gain (THEAGAIN) on mathematics tests based on the change in a person's mathematics anxiety score (MARSDIFF). The results of the pre/posttest MARS and THEA scores as well as the effect sizes are summarized in Table 12. Table 13 shows the regression results for the gain on the THEA exam based on the difference in MARS scores. Table 14 shows the relationship between the pre/posttest MARS scores and the pre/posttest THEA performance.

Table 12. MARS and THEA Pre/Posttest Scores

Test		N	M	SD	*SEM*	*d*
MARS	Pretest	123	237.16	66.77	6.02	-0.15
	Posttest	123	226.60	74.01	6.67	
THEA	Pretest	123	10.15	4.74	0.43	0.40
	Posttest	123	11.95	4.20	0.38	

Table 13. Summary of Regression Analysis for Variables Predicting Gain in THEA Scores Based on MARS Differences on Pre/Posttest Scores

	Unstandardized Coefficients		
	B	Std. Error	*t*
Constant	11.33	3.58	3.16
THEAGAIN	-0.43	0.71	-0.60

Note. Adjusted $R^2 = -0.01$; $p = n.s.$ The independent variable, THEAGAIN, is the difference between the pretest and posttest THEA scores. The dependent variable, MARSDIFF, is the difference between the pretest and posttest MARS scores.

Table 14. Summary of Regression Analysis for Pre/Posttest MARS Scores vs. Pre/Posttest THEA Scores

		Unstandardized Coefficients		
Model		B	Std. Error	*t*
1	Constant	10.77	1.59	6.78
	MARS Pretest	0.00	0.01	-0.41
2	Constant	12.22	1.23	9.94
	MARS Posttest	0.00	0.01	-0.23

Note. The independent variable for model 1 is the pretest MARS. The dependent variable is the pretest THEA. The independent variable for model 2 is the posttest MARS. The dependent variable is the posttest THEA. For both models, adjusted $R^2 = .01$; $p = n.s.$

Figures 1 and 2 show scatter graphs comparing pretest/posttest mathematics anxiety with performance on the THEA practice test. Note that there is no apparent correlation between the variables. This suggests that the relationship between the MARS and THEA scores of the participants at the beginning of the study was such that any changes in the relationship would have to be attributed to the journal-writing treatment. This is important because if there were a pre-determined relationship between the two variables on the pretest portion of the study the analysis of the posttest results would be rather complex to decipher. That is, it would be difficult to determine whether the treatment alone contributed to the decrease in MARS scores and the increase in THEA scores.

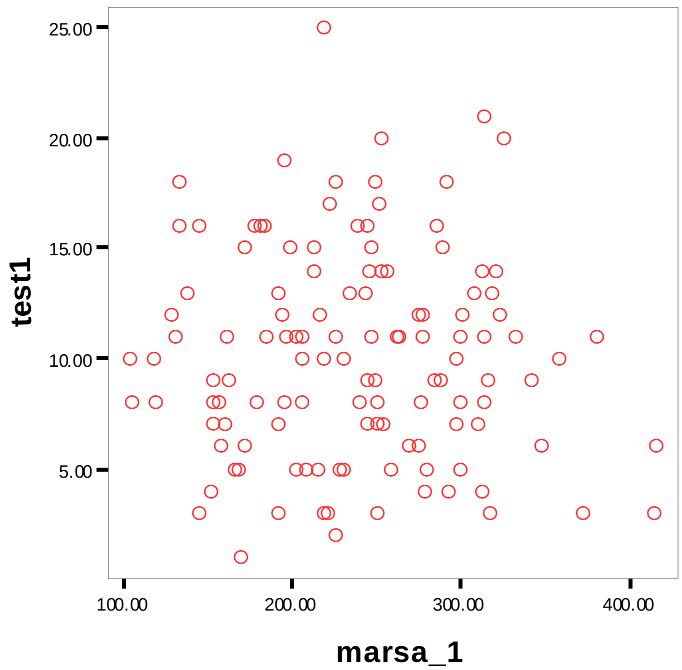

Figure 1. Pretest (marsa_1) Anxiety vs. Pretest Scores (test1)

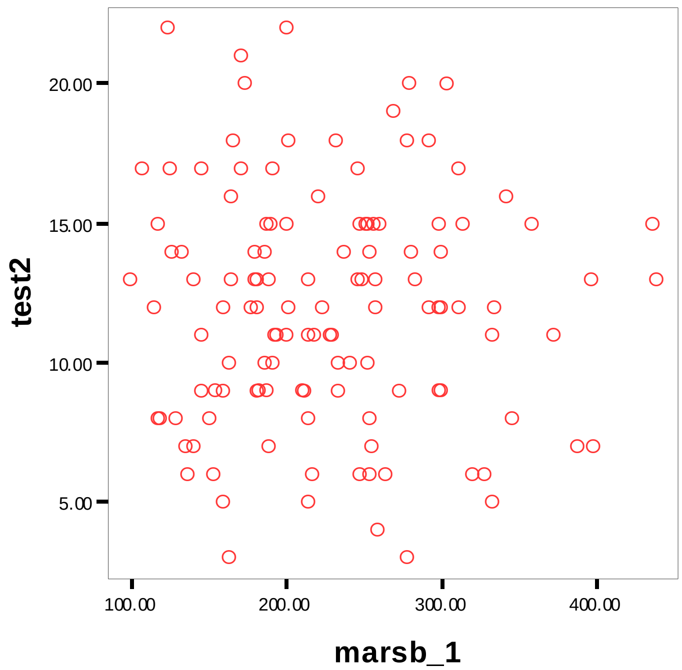

Figure 2. Posttest Anxiety (marsb_1) vs. Posttest Scores (test2)

The regression equation for the MARS posttest was not significant *F (1, 121) = 0.36, n.s.*, with an adjusted R^2 of *-0.01*. It appears that mathematics anxiety cannot be used to predict scores on the THEA practice test. The hypothesis was not supported for this study.

Mathematics Achievement and Gender

The third research question asked, "To what extent, if any, does gender play a role in success on mathematics tests for higher education students?" It was hypothesized that males and females would not differ in their performance on a mathematics test. An independent *t*-test was calculated comparing the mean mathematics test scores for males and females on the pretest. Alpha was set at *0.05*. The results are summarized in Tables 15 and 16. Table 15 shows the pretest and posttest THEA means by gender. Table 16 shows the ANOVA results between gender and THEA pretest mean scores. A statistically significant difference was found $t\ (121) = 2.22,\ p = 0.03,\ d = 0.41)$ between the THEA pretest mean for males $(m = 11.31,\ sd = 5.03)$ and the THEA pretest mean for females $(m = 9.40,\ sd = 4.41)$. The effect size suggested a medium effect between the mean pretest THEA scores between males and females. It appears males outperformed females in the pretest portion of the THEA.

Table 15. THEA Pretest and Posttest Means by Gender

		Gender	N	M	SD	*SEM*	*d*
THEA	Pretest	Male	48	11.31	5.03	0.73	0.41
		Female	75	9.40	4.41	0.51	
	Posttest	Male	48	12.75	4.10	0.59	0.31
		Female	75	11.44	4.21	0.49	

Table 16. ANOVA Summary Table for THEA Pretest Scores by Gender

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Between groups	1	107.05	107.05	4.92	0.03	0.04
Within groups	121	2632.31	21.76			
Total	122	2739.37				

The difference on the pretest means for males was enough higher than females to believe that the two groups differed at the beginning of the study. Thus, an Analysis of Covariance (ANCOVA) for the posttest achievement data using the THEA pretest as the covariate was performed to determine whether this assumption was indeed correct. The results of the ANCOVA's tests of between-subjects effects are summarized in Table 17.

Table 17. ANCOVA Results Using Posttest THEA Scores with Pretest as Covariate

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Corrected Model	2	449.00	224.50	15.82	0.00	0.21
Intercept	1	1319.45	1319.45	92.99	0.00	0.44
THEA pretest	1	398.78	398.78	28.10	0.00	0.19
Gender	1	9.00	9.00	0.63	0.43	0.01
Error	120	1702.70	14.19			
Total	123	19720.00				
Corrected Total	122	2151.71				

Note. Adjusted $R^2 = 0.20$.

Results of the ANCOVA suggest that when controlling for pre-existing differences in mathematical abilities between experimental and control groups, there was no statistically significant difference between the THEA posttest mean for males *(m = 12.75, sd = 4.10)* and the THEA posttest mean for females *(m = 11.44, sd = 4.21)*. The hypothesis was supported in this study.

Journal-Writing and Mathematics Anxiety

The fourth research question asked, “Do students who participate in a journal-writing program experience a statistically significant change in their reported levels of mathematics anxiety?” It was hypothesized that participants in a journal-writing program would report lower levels of mathematics anxiety when compared to non-participants. An independent *t*-test was calculated comparing the mean mathematics anxiety scores between participants in the experimental and control groups for the pretest. Alpha was set at *0.05*. The mean reported anxiety levels for participants in the experimental group should be lower than the mean reported anxiety levels for participants in the control group after the journal-writing treatment. The results are summarized in Tables 18 and 19. Table 18 shows the MARS pretest and posttest means by group as well as the effect sizes. Table 19 shows the *t*-test results comparing MARS pretest scores for both groups. No statistically significant difference was found $t(121) = -1.92$, *n.s.*, $d = -0.35$, between the MARS pretest mean for the experimental group ($m = 226.16$, $sd = 66.13$) and the MARS pretest mean for the control group ($m = 249.08$, $sd = 65.96$). Thus, an independent *t*-test was calculated comparing the mean mathematics anxiety scores between participants in the experimental and control groups for the posttest MARS scores. Table 20 shows the *t*-test results between the experimental and control group MARS posttest scores. A statistically significant difference was found $t(121) = -2.29$, $p = 0.02$, $d = -0.41$, between the means for the experimental group (journal writers) ($m = 212.18$, $sd = 73.52$) and the control group (non-journal writers) ($m = 242.24$, $sd = 71.92$). It appears that mathematics journal-writing decreases mathematics anxiety. The hypothesis was supported in this study. Examples of student's journal entries are provided in Tables 21-22. Table 21 lists examples of students with low levels of reported mathematics anxiety, while Table 22 lists examples of students with high levels of reported mathematics anxiety.

Table 18. MARS Pretest and Posttest Means by Group

Test		Group	N	M	SD	*SEM*	*d*
MARS	Pretest	Experimental	64	226.16	66.13	8.27	-0.35
		Control	59	249.08	65.96	8.59	
	Posttest	Experimental	64	212.18	73.52	9.19	-0.41
		Control	59	242.24	71.92	9.36	

Table 19. ANOVA Summary Table for MARS Pretest Scores by Group

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Between groups	1	16129.35	16129.35	3.70	0.06	0.03
Within groups	121	527843.30	4362.34			
Total	122	543972.70				

Table 20. ANOVA Summary Table for MARS Posttest Scores by Group

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Between groups	1	27735.45	27735.45	5.24	0.02	0.04
Within groups	121	640538.50	5293.71			
Total	122	668274.00				

Table 21. Examples of Journal Entries for Students with Low Levels of Mathematics Anxiety

Todays lecture has also been very easy. I learned everything the instructor taught us. The examples made me understand the lesson and I don't feel anxious in working with these type of problems. I feel comfortable with this lesson.

Today's lecture was on properties of logarithms and I learned how to do that and rewrite them backwards. Lecture was interesting and straight to the point. I didn't experience no fears or anxieties in the class.

Today's class/lecture was simple. It was a review and I enjoy these because the instructor gives us an opportunity to ask any questions we have before the test.

I didn't have any problem with this class period. We learned Natural Logarithms Functions. At first when I heard the name of the section, I should be honest, it scared me a little. Due to the fact that I never heard such a thing before. However as the lecture went on I didn't find it all difficult. I truly believe that I will get an A on this test coming up.

Today lecture was one of the easiest which we have encountered this semester. Exponential Exponents are a subject that I find particular easy to comprehend w/o any problems. No fears or anxieties in this lecture.

The think that helps the most is when the review is answered and explained to us. This helps us feel more confident when answering or asking questions. It also helps us find our mistakes and re-do the problem to make it correct.

Note: Grammar errors are due to direct quotes from students.

Table 22. Examples of Journal Entries for Students with High Levels of Mathematics Anxiety

2 Days lecture was somewhat similar to Wednesday. But except was much clearer to what he said last time to close things up it was alright.
I basically understood todays lecture. It really wasn't hard, but only some problems can be somewhat confusing. I felt confident I learned most part of the lesson.
April 2nd 2004-Today in the math class was a little excited about this new Lesson, because is new for me, and I would like to see more exercises like this in the next class.
The lecture today was so confusing, because with the calculator is a little strange how use it. Although this new lecture was amusing because the new way of use the logarithms is new for me. And the theacher explain all about the lecture so well.
Lecture on equations and exponents, easy to understand, no difficulties.
In today's lesson using the graphing Cal wasn't so hard. It mainly reminds me when I was in highschool.

Note: Grammar errors are due to direct quotes from students.

Journal-Writing and Mathematics Achievement

The fifth research question asked, "Does there exist a statistically significant difference in performance on mathematics tests between students who participate in a journal-writing program and those who do not participate in the program?" It was hypothesized that participants in a journal-writing program would outperform non-participants as measured by the THEA practice test. An independent *t*-test was calculated comparing the mean THEA scores between participants in the experimental and control groups for the pretest. Alpha was set at *0.05*. The mean THEA scores for participants in the experimental group should be higher than the mean THEA scores for participants in the control group after the journal-writing treatment. The results are summarized in Tables 23 and 24. Table 23 shows the THEA pretest and posttest means by group as well as the effect sizes. Table 24 shows the shows the results of the ANOVA for the THEA pretest scores for both groups. No statistically significant difference was found $t\,(121) = -0.32$, *n.s.*, $d = -0.06$, between the THEA pretest mean for the experimental group ($m = 10.02$, $sd = 4.63$) and the THEA pretest mean for the control group ($m = 10.29$, $sd = 4.89$). Thus, an independent *t*-test was calculated comparing the mean mathematics achievement scores between participants in the experimental and control groups for the posttest THEA scores. Table 25 shows the results of the ANOVA between the experimental and control group THEA posttest scores. No statistically significant difference was found $t\,(121) = -0.94$, *n.s.*, $d = -0.17$, between the means for the experimental group (journal writers) ($m = 11.61$, $sd = 4.12$) and the control group (non-journal writers) ($m = 12.32$, $sd = 4.29$). It appears that mathematics journal-writing does not affect performance on a mathematics test. The hypothesis was not supported in this study.

Table 23. THEA Pretest and Posttest Means by Group

Test		Group	N	Mean	Std. Deviation	Std. Error Mean	Effect Size
THEA	Pretest	Experimental	64	10.02	4.63	0.58	-0.06
		Control	59	10.29	4.89	0.64	
	Posttest	Experimental	64	11.61	4.12	0.51	-0.17
		Control	59	12.32	4.29	0.56	

Table 24. ANOVA Summary Table for Pretest THEA Performance by Group

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Between groups	1	2.28	2.28	0.10	0.75	0.00
Within groups	121	2737.09	22.62			
Total	122	2739.37				

Table 25. ANOVA Summary Table for Posttest THEA Performance by Group

Source	*df*	*SS*	*MS*	F	*p*	η_p^2
Between groups	1	15.59	15.59	0.88	0.35	0.01
Within groups	121	2136.12	17.65			
Total	122	2151.71				

CHAPTER V

CONCLUSION

The purpose of this study was to determine if there are differences in mathematics anxiety or mathematics performance for Hispanic/Latino male and female students enrolled in college algebra courses at a predominantly native Spanish speaking South Texas community college and if there is a relationship between a person's reported level of mathematics anxiety and their performance on mathematics tests. In addition, the study aimed to determine if students who participated in a journal-writing program experienced improvements in their reported levels of mathematics anxiety or in their mathematics performance.

Specifically, the study investigated the following questions:

(1) Does there exist a statistically significant difference in reported levels of mathematics anxiety between Hispanic/Latino male and female students enrolled in college algebra courses at a predominantly native Spanish speaking South Texas community college?

(2) Does there exist a statistically significant relationship between a person's reported level of mathematics anxiety and their performance on mathematics tests?

(3) To what extent, if any, does gender play a role in success on mathematics tests for higher education students?

(4) Do students who participate in a journal-writing program experience a statistically significant change in their reported levels of mathematics anxiety?

(5) Does there exist a statistically significant difference in performance on mathematics tests between students who participate in a journal-writing program and those who do not participate in the program?

First Research Question

Does there exist a statistically significant difference in reported levels of mathematics anxiety between Hispanic/Latino male and female students enrolled in college algebra courses at a predominantly native Spanish speaking South Texas community college?

It was hypothesized that males would be more likely to report lower levels of mathematics anxiety when compared to females. Participants were administered the MARS at the beginning of the study to determine their levels of mathematics anxiety. The pretest mean for males $(m = 238.09, sd = 73.08)$ was not statistically different from the pretest mean for females $(m = 236.56, sd = 62.91)$. Based on the data, it was inferred that both groups of participants came from the same population. Thus, the unadjusted posttest MARS scores were used to test the hypothesis. An independent samples t-test was performed and the results suggested the posttest MARS means did not differ statistically between males and females. In fact, males reported a slightly higher level of mathematics anxiety than females. The hypothesis was not supported in this study.

The results of this study seem to contradict earlier studies that females usually report a higher level of mathematics anxiety than males (Betz, 1978; Buxton, 1981; Hembree, 1990; Llabre & Suarez, 1985; Ruben, 1998). One possible reason for this paradox is that students were assured that their responses would be kept confidential. In traditional Hispanic/Latino cultures, males are often expected to not show fear, worry, anxiety, etc., while females are encouraged to openly express their emotions. However, the confidential nature of this study may have allowed males to truly express their mathematical fears without the stigma associated with revealing their personal feelings.

Another possible explanation for the mixed results could be that Hispanic/Latino students already show higher levels of mathematics anxiety (MARS scores greater than 201) than other ethnic groups (Hembree, 1990). It may be that Hispanic/Latino students just score higher on the MARS than other ethnic groups (Suinn, personal communication, February 19, 2004). The participants in this study had mean MARS scores of between 25-37 points above the 201 “average” for other ethnic groups. This would seem to indicate that there is no room to “increase” mathematics anxiety once it is already high and so there cannot be much difference in levels of reported mathematics anxiety between males and females of Hispanic/Latino ethnicity. However, the meta-analysis conducted for these results relied on only two studies. Thus, while the conclusion may be correct it may be inconclusive based on the small number of studies.

A further possible reason for the inconsistency with previous research could be the sample that was used for this study. The research relating gender and mathematics anxiety is plenty, but when compared to the research focusing on Hispanic/Latino community college students it seems as if there is very little literature that focuses solely on this ethnic group. The argument can then be made that perhaps the MARS may not be a very helpful measuring instrument when it comes to this sample group. Additional studies concentrating on Hispanic/Latino students would have to be conducted to determine the extent of usefulness for the MARS on this group.

To summarize, the results from this study suggested that gender does not affect the levels of self-reported mathematics anxiety. The participants' ethnic background may be a factor explaining why there was no statistical difference found. Another possible explanation could be the already high levels of mathematics anxiety that this sample experiences. Lastly, it may seem that the instruments used to measure mathematics anxiety may not be helpful for Hispanic/Latino students.

Second Research Question

Does there exist a statistically significant relationship between a person's reported level of mathematics anxiety and their performance on mathematics tests?

It was hypothesized that mathematics anxiety and mathematics achievement, as measured on a mathematics test, would be inversely related. That is, higher levels of mathematics anxiety would result in lower mathematics achievement scores and lower levels of mathematics anxiety would result in higher mathematics test scores. Results of the second research questions suggest that mathematics anxiety, specifically the difference between the pretest and posttest, cannot be used to predict scores on the THEA practice test, specifically the increase in the THEA scores. The hypothesis was not supported in this study.

One possible explanation could be that participants' were only given 50 minutes to complete the examination. In this time span, some students may have walked in late to class or left for brief moments to attend to personal needs and therefore they had less time to answer the questions. Additionally, the time frame may not have been sufficient for participants to successfully attempt and/or complete all the questions on the THEA practice test.

Another possible factor could be that the types of problems found on the THEA may not have been representative of the material lectured in class during the course of the study. Thus, it may have been more useful to correlate the test problems with the course content to better understand any possible relationships that exist between mathematics anxiety and mathematics test performance.

In summary, it appears that mathematics anxiety cannot be used to predict scores on a mathematics exam. This may have occurred because of a limited time frame for completing the test or because the THEA practice exam may not have been representative of the material covered in the course.

Third Research Question

To what extent, if any, does gender play a role in success on mathematics tests for higher education students?

It was hypothesized that males and females would not differ in their performance on a mathematics test. Results of the third research question suggest that gender is not a factor in determining success on mathematics tests. This is consistent with results from the meta-analysis study (Hembree, 1990). The THEA pretest did show statistically significant differences on mathematics achievement based on gender, however this was most likely due to the preexisting differences in mathematical abilities between the experimental and control groups.

As a result, an ANCOVA was performed for the posttest achievement data using the THEA pretest as the covariate. Results of the ANCOVA suggest that when controlling for pre-existing differences in mathematical abilities between experimental and control groups, there was no statistically significant difference between the THEA posttest means for males or females. The hypothesis was supported in this study.

This suggestion is important because it may be used as further evidence that males, as well as females, are equally capable of performing mathematical tasks. The implication is that educators should not try to discourage females from pursuing mathematical fields. Rather, they should strive for equality in these fields. If we as a society are to keep improving, it is vital to tap into all available human resources.

Fourth Research Question

Do students who participate in a journal-writing program experience a statistically significant change in their reported levels of mathematics anxiety?

It was hypothesized that participants in a mathematics journal-writing program would report lower levels of mathematics anxiety when compared to non-participants. Results of the fourth research question suggest that participating in a mathematics journal-writing program has a positive effect in reducing mathematics anxiety. The hypothesis was supported in this study.

The data supports the notion that journal writing can be an effective tool in lowering levels of mathematics anxiety (Borasi & Rose, 1989; Ganguli, 1989; Sgoutas-Emch & Johnson, 1998; Grossman, Smith, & Miller, 1993; Miller, 1992). One possible reason for this is that students are able to express their fears and worries in a relaxed environment (Borasi & Rose, 1989). This is one type of communication that is essential for learning, doing, and understanding mathematics (Cai & Kenney, 2000). It also "allows teachers to get a better understanding and feel for any frustration students are experiencing" (Furner & Duffy, 2002, p. 70). It is interesting to note that mean mathematics anxiety scores for the experimental group was 30 points lower than for the control group. This may suggest that if a study is conducted throughout the entire semester journal-writers may experience a greater drop in their reported levels of mathematics anxiety.

Fifth Research Question

Does there exist a statistically significant difference in performance on mathematics tests between students who participate in a journal-writing program and those who do not participate in the program?

It was hypothesized that participants in a journal-writing program would outperform non-participants as measured by the THEA practice test. Results of the fifth question suggest that participation in a mathematics journal-writing program does not increase achievement levels on a mathematics test. The hypothesis was not supported in this study.

One possible explanation for this result is that the mathematics test used to measure mathematical achievement may not have been appropriate. The THEA practice test that was used may not have been closely related to the material being covered in class. Thus, this may have resulted in some skewed results. However, with a longer study and a test that is more closely related to the material that is being lectured on, these results may yield better and more informative data.

Limitations

There were a few limitations for this study. To begin with, the study was conducted at a community college just blocks away from the Mexican border. The unique culture associated with cities bordering Mexico, such as language acquisition/usage, parental involvement, and local customs may play a factor in the generalizability of this study.

Secondly, the study focused only on Hispanic/Latino traditional students ranging in ages between 18-25 enrolled in a college algebra course. Thus, the results of this study may not yield comparable statistics for other college-level courses, such as calculus where students generally enjoy mathematics. In addition, older participants may have different levels of school maturity and thus results with non-traditional students may yield different results.

Next, the study was conducted within a three-week span. As a result of this relatively short time span, some students may not have had enough time to fully integrate themselves in the journal-writing process, thus reporting higher levels of mathematics anxiety than could have been accomplished.

Lastly, the measuring instruments (MARS/THEA) may not have been the most appropriate for this particular group of participants. According to the developer of the MARS, Dr. Richard M. Suinn,

> A long time ago, we had some jr/sr high data suggesting that Hispanics scored higher, but we had no way of determining what this meant, e.g., whether different norms were needed. We did have a sample of Hispanic elementary students and their mean score was no different from white students (personal communication, February 19, 2004).

This may lend more credence that maybe a revised MARS and/or a new survey needs to be established to better assess levels of mathematics anxiety for Hispanic/Latino students for all grade levels.

Directions for Further Research

Because of the literature review, there are two issues that deserve further consideration for research. The first is that research should be conducted to determine if students' mathematics performance will increase by having a mathematics teacher, instead of a general education teacher, teach the mathematics sections in elementary schools. This may help increase the number of elementary education majors who select mathematics as an area of specialization while simultaneously reducing the levels of mathematics anxiety passed on to elementary school students.

Secondly, research should be conducted to determine at what age or grade level students may begin to dislike or develop debilitating mathematics anxiety. If mathematics educators can help fight off many of the mathematics anxieties early in the students' education, then maybe more people will want to study mathematics and its related fields.

Based on this study, it is suggested that further research be conducted with the following items in mind:

(1) A longer time frame so that students can immerse themselves into the journal-writing process.

(2) A more appropriate instrument to measure mathematics achievement.

(3) A more appropriate instrument to measure mathematics anxiety.

(4) Participants from different remedial/developmental courses as well as college courses.

(5) Participants from universities as well as community colleges.

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APPENDIX A

CONSENT FORM

The Impact of Mathematics Anxiety, Gender, and Mathematics Achievement on Ontogenetic Indicators for Hispanic/Latino Students in Higher Education Mathematics Classes

I have been asked to participate in a research study concerning mathematics anxiety and mathematics achievement. I was selected to be a possible participant because I am currently enrolled in a college algebra course. A total of approximately 100 males and 100 females have been asked to participate in this study. The purpose of this study is (1) to determine the levels of mathematics anxiety for students in college algebra classes, (2) to determine how mathematics anxiety and scores on mathematics tests are related, (3) to determine if there exists a relationship between gender and performance on mathematics tests, (4) to determine if keeping a written mathematics journal helps in performance on mathematics tests, (5) to determine if there exists a relationship between scores on mathematics tests and participation in a journal writing program, and (6) to fulfill doctoral degree requirements for the principal investigator, Armando I. Pérez.

If I agree to be in this study I may be asked to keep a written mathematical journal during the last five minutes of class. This study will only take approximately 4 weeks (8 class meetings). The possible risks associated with this study are minimal, if any. The possible benefits of participating are a reduction in mathematics anxiety and an increase in mathematics test scores. I will not receive any money or extra credit for participating in the study. This study is confidential. I will be assigned a random number for identification purposes. The records of this study will be kept private. No identifiers linking me to the study will be included in any sort of report that might be published. Research records will be stored securely and only the principal investigator, Armando I. Pérez, and his doctoral committee, Dr. Gerald O. Kulm (co-chair), Dr. Robert M. Capraro (co-chair), Dr. Jon Pitts, and Dr. G. Donald Allen will have access to the records. My decision whether or not to participate will not affect my current or future relations with Texas A&M University or Laredo Community College. If I decide to participate, I am free to refuse to answer any of the questions that may make me uncomfortable. I can withdraw at any time without my relations with the university, college, class, etc., being affected. The principal investigator may withdraw me from the study if I am not cooperating with his directions.

If I have any questions about this study I can contact Armando I. Pérez at Mathematics Department, Laredo Community College, West End Washington St., Laredo, TX 78040, (956) 764-5728, arperez@laredo.edu or Dr. Gerald O. Kulm, Curtis D. Robert Professor of Mathematics Education at Department of Teaching, Learning, and Culture, Texas A&M University, College Station, TX 77843-4232, (979) 862-4407, gkulm@coe.tamu.edu. This research study has been reviewed by the Institutional Review Board- Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, I can contact the institutional Review Board through Dr. Michael W. Buckley, Director of Research Compliance, Office of Vice President for Research at (979) 845-8585 (mwbuckley@tamu.edu). I have read the above information. I have asked questions and have received answers to my satisfaction. I have been given a copy of this consent document for my records. By signing this document, I consent to participate in the study.

Signature: ____

Date: ___________________

Signature of Investigator: ___________________________________

Date: ___________________

APPENDIX B

MATHEMATICS ANXIETY SURVEY

Please write down your identification number: _____________

Gender (circle one)   (1) Male   (2) Female

Ethnicity (circle one)   (1) Hispanic/Latino   (2) Other

Age (circle one):   18-21   22-25   26-29   over 29

My high school education or equivalent schooling was completed in: (check one)

United States □   Mexico □

My high school education or equivalent schooling was completed in: (check one)

Private School □   Public School □

I was raised in a predominantly: (circle one)

(a) Blue-collar/Working class family (manual labor, factory workers, mechanics, etc.)

(b) White-collar/Professional family (teachers, business executives, accountants, etc.)

My college is funded by:
Check all that apply

My parents □   A relative □   My Savings □   My full-time employment □

Scholarship □   A part-time job □   Financial Aid □

VITA

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